

Standard Operating Procedure for Determination of Radon in Water

1.0 Location

Room 310.

2.0 Purpose

This method determines the amount of Radon 222 in water in pCi/L.

3.0 Scope

A water sample is collected and mailed immediately to this lab for radon analysis by liquid scintillation in support of Environmental Health. The detection limit is 100 pCi/L. Precision is $\pm 10\%$ error and accuracy is $\pm 25\%$.

4.0 References

4.1 Packard 2500 TR Operating Manual.

4.2 Instructions for operation of Niton Software - (See Niton Software Operating Manual).

4.3 Instructions for operation of liquid scintillation counter (See Packard 2500 TR Operating Manual).

5.0 Sample Handling and Preservation

5.1 Collection

5.1.1 Run cold water for 15 minutes.

5.1.2 Remove aerator.

5.1.3 Slowly fill vial with water until it overflows and forms a dome.

5.1.4 With the liner firmly in the cap, place the cap on the vial.

5.1.5 Turn the vial upside down. If there is an air bubble larger than 1/4", repeat procedure.

5.1.6 Mail to lab immediately.

5.2 Maximum time from collection to test: 192 hours (8 days).

5.3 Minimum elution time: 3 hours.

6.0 Apparatus and Materials

6.1 Packard Liquid Scintillation Counter 2500 TR.

6.2 CMS 20 ml glass liquid scintillation vials #267-459.

6.3 10 ml dispenser.

6.4 Optifluor 0 cocktail #6013426 (Packard) or mineral oil cocktail NEF-957A (New England Nuclear).

6.5 Water collection vials with septum in cap (Niton).

6.6 Quality Control Samples from EPA (Ra 226 generators).

7.0 Procedures

7.1 Calibration

A cassette labeled SNC/IPA and containing unquenched C-14, H-3, and a background vial is placed in the LS counter flagged once per week. This normalizes the photo multiplier tubes. A background is counted. Efficiencies, figure of merit, and chi squares are calculated. Once per month these values are printed out for hard copy storage. These values must meet the specification listed in Chapter 1 of the Packard operating manual or the instrument manufacturer is contacted.

7.2 Analysis

7.2.1 10 ml of Optifluor is dispensed into all 20 ml LS vials.

7.2.2 10 mls of Blank water, control water or sample water is drawn into a 20 ml glass syringe with needle and dispensed under the 10 ml of cocktail in the LS vial slowly to assure no escape of radon gas from the vial. Rinse syringe between samplings.

- 7.2.3 Shake vials for about 5 seconds to equilibrate.
- 7.2.4 The elution time is noted for each cassette.
- 7.2.5 A cassette with an empty liquid scintillation vial (Protocol #10 - dummy) is placed in the counter in front of the cassettes with samples to be counted (Protocol #4 - Ra in H₂O).
- 7.2.6 A 7-8 hour delay is used (3 hour is minimum) as this is the minimum elution time for radon in air and radon in air cassettes and radon in water cassettes will be counted together. Place radon in water cassettes in order after the dummy, then radon in air cassettes.
- 7.2.7 Press the start button to start the LS counter.
- 7.2.8 Press F5 (DOS exit) to exit Packard software.
- 7.2.9 Type cd\radon.
- 7.2.10 Type start manual.
- 7.2.11 Type in your 3 user initials.
- 7.2.12 Choose new order entry.
- 7.2.13 Type in ND for last name/company.
- 7.2.14 Page down to vial # - enter log # (Example if log # is 92-E412, enter 412).
- 7.2.15 Enter water for test.
- 7.2.16 Enter the month, day, and military time for expose (this is the collection time for water samples).
- 7.2.17 For stop date and time, hit enter for the computer to automatically enter the date and time, the same as expose date and time.
- 7.2.18 Enter the cassette and position # in cassette.

- 7.2.19 Upon completion of 10 positions, press F10 to file the order.
- 7.2.20 Choose elution from menu - enter cassette # and elution date and time.
- 7.2.21 Type exit to return to Packard software.
- 7.2.22 Upon completion, press F5 (exit to DOS), cd\radon, start auto c, to print out summary of results.
- 7.2.23 Alternate procedure if radon in air is counted after radon in water on the same day. Upon completion press F5 (exit to DOS), cd\radon, start manual. Choose test results, enter cpm for each sample, F10 (to save), exit.
- 7.2.24 Choose view, enter order number highlight each sample by pressing F9 to enter time analyzed.
- 7.2.25 When all samples are complete, press F10, exit.
- 7.2.26 Press print, select order number to print, press print to printer.
- 7.2.27 Enter results into LIMS via worklist.
- 7.2.28 Step by step instructions for operating the Packard liquid scintillation counter are found in Packard's Operating Manual and instructions for using radon software are found in the Niton Software Operating Manual.

8.0 Quality Assurance/Quality Control

8.1 Blanks

SuperQ Water purged with helium to remove radon is used as a blank (the same procedure as unknown).

8.2 Replicates

Replicates are sent in from participants at the discretion of the Environmental Health Section.

8.3 Quality Control Samples

EPA Known Ra226 - Ra222 samples can be used (the same procedure as unknowns). Acceptable accuracy is $\pm 25\%$ and acceptable replication is $\pm 10\%$. The instrument manufacturer is called if these limits are not met.

9.0 Data Analysis

9.1 The raw counts per minute are converted to pCi/L by the Niton Software.

$$C(\text{pCi/L}) = (N - \text{NBkg}) \times 100 / (5 \times 2.22 \times .964)$$

C = result for sample in pCi/L

N = Cpm

NBKg = Cpm for background

5 = 3 alphas + 2 betas

2.22 = dpm in 1 pCi

.964 = correction for radon in air and not in cocktail

9.2 The calculated results are entered into the LIMS via worklist, reports for samples are printed and copies are sent to Environmental Health, copies are retained in the lab files. Quality Control samples are identified as Class Q, results are calculated and entered into the LIMS and printed reports are signed by the Director of Chemistry and are filed in the laboratory.

10.0 Documentation

10.1 When the water samples are received, they are assigned log numbers and are logged into the LIMS system. Bench sheets are given to the analyst.

10.2 The analyst creates a worklist to use for entering necessary data into the Niton software on the LS counter and to record calculated results entry into the LIMS.

10.3 Final calculated results are entered on the bench sheets which are used for validating results on the printed reports.

11.0 Records

11.1 Completed worklists, bench sheets, a copy of the summary of counts per minute and results from Niton software, and a copy of the report are filed

at the Chemistry laboratory.

11.2 Report copies are sent to the Environmental Health Section.